This is the **Higher Combined Science** version. Higher Tier questions (★) are included. Some Separate-only content has been omitted.

DNA and Chromosomes (4.6.2)

Specification reference: 4.6.2

Q1. Describe the structure of a DNA molecule.

[3 marks]

Q2. Explain the relationship between DNA, genes and chromosomes.

[3 marks]

★ HIGHER TIER

Q3. ★ Describe the process of protein synthesis, naming the molecules and locations involved.

[4 marks]

Meiosis and Reproduction (4.6.1)

Specification reference: 4.6.1

Q4. Explain why meiosis produces cells that are genetically different from each other.

[3 marks]

Q5. Compare sexual and asexual reproduction in terms of the number of parents, genetic variation and type of cell division.

[3 marks]

Genetic Inheritance and Punnett Squares (4.6.3)

Specification reference: 4.6.3

Q6. Define the following terms: (a) dominant allele, (b) recessive allele, (c) genotype, (d) phenotype.

[4 marks]

Q7. Brown eye colour (B) is dominant over blue (b). Two parents both have genotype Bb. Use a Punnett square to calculate the probability their child has blue eyes.

[3 marks]

Q8. Polydactyly is caused by a dominant allele (D). Cystic fibrosis is caused by a recessive allele (f). Explain why someone with one copy of the polydactyly allele (Dd) will have extra digits, but a cystic fibrosis carrier (Ff) will appear unaffected.

[3 marks]

★ HIGHER TIER

Q9. ★ Explain what is meant by co-dominance. Give ONE example.

[2 marks]

Natural Selection and Evolution (4.6.5)

Specification reference: 4.6.5

Q10. Describe how natural selection can lead to changes in a species over many generations. Use all of the following terms: variation, competition, survival, inheritance.

[5 marks]

Q11. State THREE pieces of evidence that support the theory of evolution.

[3 marks]

★ HIGHER TIER

Q12. ★ Explain how speciation can occur when a population of organisms becomes geographically isolated.

[4 marks]

★ HIGHER TIER

Q13. ★ Describe the process of genetic engineering. Name the enzymes used at each stage.

[4 marks]

Total: 44 marks

DNA and Chromosomes (4.6.2)

Q1 (3 marks)

Describe the structure of a DNA molecule.

• Double helix — two strands twisted together [1]
• Made of nucleotides, each containing a sugar, phosphate and one of four bases (A, T, C, G) [1]
• Complementary base pairing: A-T and C-G hold the two strands together [1]

Q2 (3 marks)

Explain the relationship between DNA, genes and chromosomes.

• DNA is a long molecule carrying genetic information [1]
• A gene is a section of DNA that codes for a specific protein/characteristic [1]
• Chromosomes are long strands of DNA coiled up and carrying many genes — humans have 46 in 23 pairs [1]

Q3 (4 marks) [★ HT]

★ Describe the process of protein synthesis, naming the molecules and locations …

• Transcription in nucleus: template strand of DNA copied into mRNA using complementary base pairing (U replaces T in mRNA) [1]
• mRNA leaves nucleus through nuclear pores [1]
• Translation at ribosome: ribosome reads mRNA codons (triplets of 3 bases) [1]
• tRNA molecules bring specific amino acids; peptide bonds form between amino acids → polypeptide chain (protein) [1]

Meiosis and Reproduction (4.6.1)

Q4 (3 marks)

Explain why meiosis produces cells that are genetically different from each othe…

• During meiosis, homologous chromosomes pair up and sections of DNA are exchanged (crossing over) — creating new allele combinations [1]
• Chromosomes then separate randomly (independent assortment) — each gamete receives a random mix of maternal and paternal chromosomes [1]
• Fertilisation combines two gametes — the combination of alleles in offspring is unique [1]

Q5 (3 marks)

Compare sexual and asexual reproduction in terms of the number of parents, genet…

• Asexual: one parent; sexual: two parents [1]
• Asexual: offspring are genetically identical (clones); sexual: offspring are genetically different [1]
• Asexual: uses mitosis; sexual: uses meiosis (to produce gametes) [1]

Genetic Inheritance and Punnett Squares (4.6.3)

Q6 (4 marks)

Define the following terms: (a) dominant allele, (b) recessive allele, (c) genot…

• (a) An allele that is expressed when only one copy is present — masks recessive [1]
• (b) An allele that is only expressed when two copies are present [1]
• (c) The alleles an individual carries (e.g. Bb) [1]
• (d) The observable characteristic produced by the genotype (e.g. brown eyes) [1]

Q7 (3 marks)

Brown eye colour (B) is dominant over blue (b). Two parents both have genotype B…

• Correct Punnett square: BB, Bb, Bb, bb [1]
• 1 in 4 / 25% probability of blue eyes (bb genotype) [1]
• Phenotype ratio: 3 brown : 1 blue [1]

Q8 (3 marks)

Polydactyly is caused by a dominant allele (D). Cystic fibrosis is caused by a r…

• Polydactyly allele is dominant — expressed whenever present, even with only one copy [1]

• Cystic fibrosis allele is recessive — only expressed when two copies present (ff) [1]

• Carrier (Ff) has one dominant normal allele that masks the recessive cystic fibrosis allele [1]

Q9 (2 marks) [★ HT]

★ Explain what is meant by co-dominance. Give ONE example.

• Co-dominance: both alleles are expressed equally in the phenotype of a heterozygote — neither dominates [1]

• Example: ABO blood group — I■ and I■ are co-dominant; I■ I■ genotype gives type AB blood [1] — accept: sickle cell trait

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Natural Selection and Evolution (4.6.5)

Q10 (5 marks)

Describe how natural selection can lead to changes in a species over many genera…

• Variation exists within a population due to mutations and sexual reproduction [1]

• Individuals compete for limited resources (food, water, mates, space) [1]

• Individuals with advantageous characteristics are more likely to survive and reproduce [1]

• Survivors pass on the alleles for their advantageous characteristics to offspring (inheritance) [1]

• Over many generations, the frequency of advantageous alleles increases — the population changes [1]

Q11 (3 marks)

State THREE pieces of evidence that support the theory of evolution.

• Fossil record — shows gradual changes in species over millions of years [1]

• DNA evidence — closely related species share more similar DNA sequences [1]

• Observable examples of natural selection today (e.g. antibiotic resistance in bacteria) [1] — accept: comparative anatomy

Q12 (4 marks) [★ HT]

★ Explain how speciation can occur when a population of organisms becomes geogra…

• A barrier (mountain range, sea, river) divides the population into two isolated groups [1]

• The two groups experience different environmental conditions → different selection pressures [1]

• Different mutations arise and different alleles are selected for in each group [1]

• Over many generations, the two groups become so genetically different they can no longer interbreed to produce fertile offspring → new species [1]

Q13 (4 marks) [★ HT]

★ Describe the process of genetic engineering. Name the enzymes used at each sta…

• Desired gene identified and cut out of donor DNA using restriction enzymes [1]

• Plasmid (vector) cut open with the same restriction enzyme → complementary sticky ends [1]

• Gene inserted into plasmid; DNA ligase seals the joins → recombinant DNA [1]

• Recombinant plasmid introduced into host cell (e.g. bacterium); host expresses the gene and produces the desired protein [1]